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(54) METHOD FOR MANUFACTURING ULTRAFINE SHORT FIBERS

Abstract

The present invention pertains to a method for manufacturing ultrafine short fibers and is characterized by the fact that in manufacturing ultrafine short fibers by discharging and jetting a high-temperature polymer solution onto a collector (8) through a spinning nozzle (6) under high pressure, a high voltage is applied to each of the above-mentioned spinning nozzle (6) and collector (8) by a voltage applier (12). In the present invention, compared with the prior art, ultrafine short fibers can be manufactured with a high production efficiency, and the stability is improved. The short fibers manufactured by the present invention are used for medical nonwoven fabrics and industrial nonwoven fabrics.

Representative figure:

Figure 3

Key words:

Ultrafine, short fibers, solution spinning, electrostatic spinning, voltage, high pressure, and production efficiency

Specification

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is an outlined diagram showing a conventional electrostatic spinning process.

Figure 2 is an outlined diagram showing a conventional solution spinning (flash spinning) process.

Figure 3 is an outlined diagram showing the spinning process of the present invention.

* Explanation of numerals of the main parts of the figures

1 Polymer solution storage tank
2 Pressure pump
3 Polymer solution
4 Decompression orifice
5 Spinneret
6 Spinning nozzle
7 Short fiber
8 Collector
9 Spinning area
10 Solvent recovery device

11 Insulator layer

12 Voltage applier

DETAILED EXPLANATION OF THE INVENTION

PURPOSE OF THE INVENTION

TECHNICAL FIELD OF THE INVENTION AND PRIOR ART

The present invention pertains to a method for manufacturing ultrafine fibers by spinning a polymer solution. More specifically, the present invention pertains to a method for manufacturing ultrafine fibers with a finer size with high productivity by spinning a polymer solution using an electrostatic-solution spinning method.

In the present invention, "ultrafine short fibers" means short fibers (staple fibers) with a size (diameter) of several tens of nanometers or less. The ultrafine fibers are broadly used in various applications such as medical stitching nonwoven fabrics and industrial filters.

Conventional ultrafine short fibers have been manufactured mainly by an electrostatic spinning method or solution spinning (flash spinning) method.

In Japanese Kokai Patent Application No. Hei 3[1991]-161502 and U.S. Patent No. 4,323, 525, methods for manufacturing ultrafine short fibers by the electrostatic spinning method are proposed.

Figure 1 is an outlined diagram showing a process for manufacturing ultrafine short fibers by the electrostatic spinning method. The electrostatic spinning method is a process for manufacturing short fibers by introducing a polymer solution (3) into an electric field. More specifically, it is a method that manufactures ultrafine short fibers by spinning (jets) a polymer solution through a spinning nozzle (5) having a + electrode and collecting it by a suction collector (8) having a – electrode.

However, in the above-mentioned electrostatic spinning method, although the size of the short fibers could be made fine, since solvents used in dissolving the polymer were unstable, there was a limitation in the mass production, and the productivity was inferior.

On the other hand, Figure 2 is an outlined diagram showing a process for manufacturing ultrafine short fibers by the conventional solution spinning method. It is a method that introduces a polymer solution into a storage tank (1) and into a spinneret (5) by a pressure pump (2), manufactures a high-temperature and high-pressure polymer solution by heating and pressurizing, and spins (jets) it onto a collector (8) through a spinning nozzle (6). However, in the above-mentioned solution spinning method, although the productivity was high and mass production was possible, since a high pressure was applied, it was dangerous; in particular, there was a limitation in making the size of the short fibers fine.

The present invention solves these conventional problems, and its purpose is to provide a manufacturing method that can mass-produce ultrafine short fibers of nanometer size with high productivity.

TECHNICAL PROBLEMS TO BE SOLVED BY THE INVENTION

The present invention provides a method that can mass-produce ultrafine short fibers of nanometer size with high productivity by organically combining a solution spinning method and an electrostatic spinning method. Also, the present invention provides a method for manufacturing ultrafine short fibers that can prevent accidents that may be caused due to high voltage during solution-spinning.

CONSTITUTION AND OPERATION OF THE INVENTION

In order to achieve the above objective, the method for manufacturing ultrafine short fibers of the present invention is characterized by the fact that in manufacturing ultrafine short fibers by discharging and jetting a high-temperature polymer solution onto a collector (8) through a spinning nozzle (6) under high pressure, a high voltage is applied to each of the above-mentioned spinning nozzle (6) and collector (8) by a voltage applier (12).

Next, the present invention is explained in detail using the attached figures.

The present invention is characterized by the fact that a solution spinning method and an electrostatic spinning method are organically combined by applying a high voltage by a voltage applier (12) to the spinning nozzle (6) and the collector (8), with short fibers being manufactured by an ordinary solution spinning method.

Figure 3 is an outlined diagram showing the process of the present invention.

In the present invention, first, a polymer solution (3) is prepared by dissolving a polymer in a solvent, then stored in a storage tank (1). As the polymer, polyvinyl alcohol, polyvinyl butylenes, polyacrylonitrile, polyethylene terephthalate, polytetrafluoroethylene, polyurethane, polyester, polyamide, etc., can be used. As the solvent, one that can dissolve the corresponding polymer is appropriately selected and used in accordance with the polymer.

In the above-mentioned polymer solution, additives such as a resin, plasticizer, ultraviolet stabilizer, crosslinking agent, curing agent, and reaction initiator compatible with the corresponding polymer can also be mixed.

The polymer solution prepared in this manner and stored in the storage tank (1) is transferred into the spinneret (5) by a pressure pump (2); the polymer solution in the spinneret (5) is set to a high-temperature/high-pressure state by heating and pressurizing. A decompression orifice (4) is preferably installed in the intermediate part of the spinneret (5).

Next, the polymer (3) in a high-temperature/high-pressure state is spun into an electric field through the spinning nozzle (6). The above-mentioned electric field is formed between the spinning nozzle (6) and the collector (8), to which the voltage is applied. Specifically, the voltage is applied to the above-mentioned spinning nozzle (6) and collector (8) by a voltage applier (12).

Thus, an electric field is formed between them. At that time, the + electrode is applied to the spinning nozzle (6) and the – electrode is applied to the collector (8). It is preferable to adjust the voltage being applied to the spinning nozzle (6) and the collector (8) to 10-60 kV for an ultra-fine processing of the short fibers.

Also, the same voltage can be applied to the spinning nozzle (6) and the collector (8); different voltages can also be applied.

It is preferable to install an insulator layer (11) at the lower end of the above-mentioned spinneret (5) to prevent the voltage being applied to the spinning nozzle (6) from being transmitted to the upper end of the spinneret (5). The above-mentioned collector (8) has a suction function for absorbing air and collects the spun short fibers in a web state. At one side of a spinning area, a solvent recovery device (10) is installed and recovers the solvent after spinning.

In the present invention, since the polymer solution in a high-temperature/high-voltage state is jetted into the electric field, the size of the short fibers (7) can be made fine, at a level of 50 nm or less. Also, in the present invention, since most of the conventional solution spinning process is adopted as is, the productivity is high, and mass production is also possible. Furthermore, in the present invention, the decompression orifice (4) is installed in the spinneret (5), so that accidents can also be effectively prevented.

Next, the present invention is explained in detail with application examples. However, the present invention is not limited to the following application examples.

APPLICATION EXAMPLE 1

A 6% polymer solution was prepared by dissolving a fiber-forming polyvinyl butylene (Germany Rext [transliteration] Co., B60 T) in isopropyl alcohol. The above-mentioned polymer solution was supplied to the spinneret (5) of Figure 3; after applying heat and pressure, short fibers were manufactured by spinning through the spinning nozzle (6), to which the + electrode was applied, then onto the collector (8) to which the – electrode was applied. At that time, the insulator layer (11) was installed in the above-mentioned spinneret (5), and the solvent recovery device (10) was installed in the spinning area (9). Also, a voltage of 25 kV was applied to the spinning nozzle (6), and a voltage of 10 kV was applied to the collector (8). The size

(average diameter) of the short fibers manufactured was 10 nm, and the production efficiency was 95.5%.

APPLICATION EXAMPLE 2

A 6% polymer solution was prepared by dissolving a fiber-forming polyvinyl alcohol in isopropyl alcohol. The above-mentioned polymer solution was supplied to the spinneret (5) of Figure 3; after applying heat and pressure, short fibers were manufactured by spinning through the spinning nozzle (6), to which the + electrode was applied, the onto the collector (8) to which the– electrode was applied. At that time, the insulator layer (11) was installed in the above-mentioned spinneret (5), and the solvent recovery device (10) was installed in the spinning area (9). Also, a voltage of 25 kV was applied to the spinning nozzle (6), and a voltage of 10 kV was applied to the collector (8). The size (average diameter) of the short fibers manufactured was 8 nm, and the production efficiency was 96.7%.

APPLICATION EXAMPLE 3

A 6% polymer solution was prepared by dissolving a fiber-forming polyurethane in a mixed solvent of dimethylformamide/methyl ethyl ketone. The above-mentioned polymer solution was supplied to the spinneret (5) of Figure 3; after applying heat and pressure, short fibers were manufactured by spinning through the spinning nozzle (6), to which the + electrode was applied, then onto the collector (8) to which the – electrode was applied. At that time, the insulator layer (11) was installed in the above-mentioned spinneret (5), and the solvent recovery device (10) was installed in the spinning area (9). Also, a voltage of 25 kV was applied to the spinning nozzle (6), and a voltage of 10 kV was applied to the collector (8). The size (average diameter) of the short fibers manufactured was 5 nm, and the production efficiency was 97.2%.

EFFECTS OF THE INVENTION

According to the present invention, the size of short fibers can be made ultra-fine, to a level of several tens of nanometers or less, the above-mentioned ultrafine short fibers can be mass-produced with high productivity, and accidents due to a high voltage can be prevented.

(57) Claims

1. A method for manufacturing ultrafine short fibers, characterized by the fact that in manufacturing ultrafine short fibers by discharging and jetting a high-temperature polymer solution onto a collector (8) through a spinning nozzle (6) under high pressure, a high voltage is applied to each of the above-mentioned spinning nozzle (6) and collector (8) by a voltage applier (12).

2. The method for manufacturing ultrafine short fibers of Claim 1, characterized by the fact that an insulator layer (11) is installed at the lower end of the spinneret (5).

3. The method for manufacturing ultrafine short fibers of Claim 1, characterized by the fact that the voltage being applied to the spinning nozzle (6) and the collector (8) is 10-60 kV.

4. The method for manufacturing ultrafine short fibers of Claim 1, characterized by the fact that a + electrode is applied to the spinning nozzle (6) and a – electrode is applied to the collector (8).

Figure 1

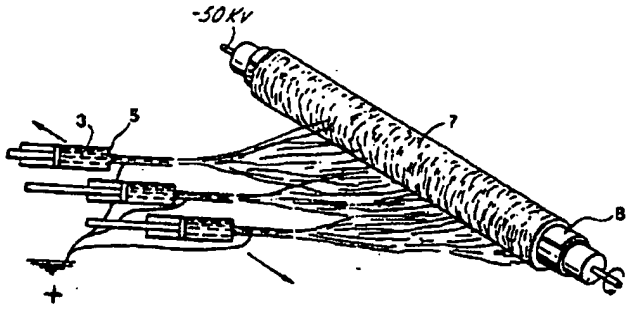


Figure 2

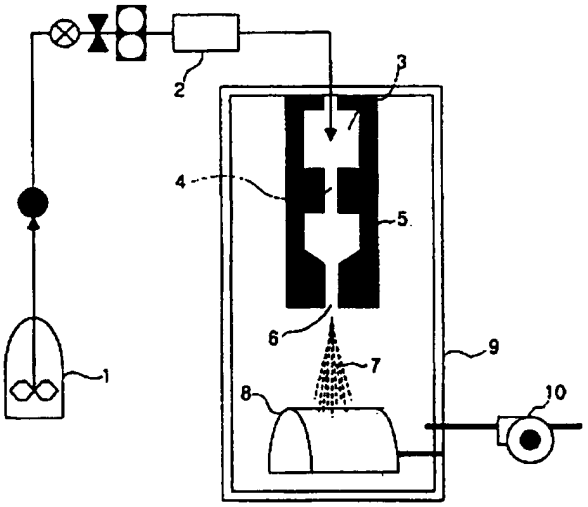
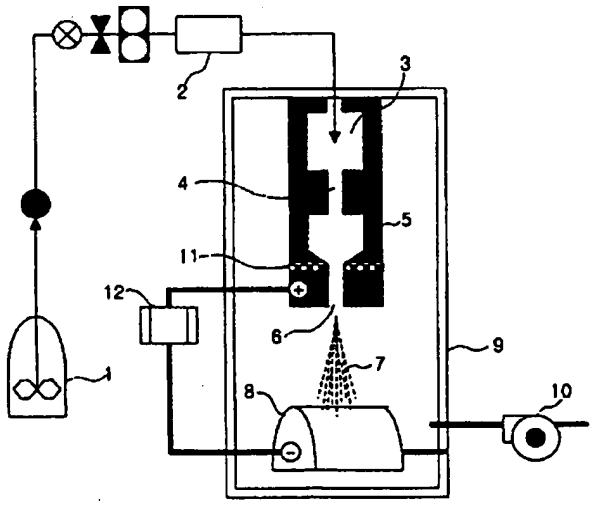


Figure 3



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